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United States Department of Agriculture,

DIVISION OF BOTANY.

CHICORY GROWING.

Chicory (*Cichorium intybus* L.) (fig. 1), or succory, as it is often called, has become naturalized from Europe as a troublesome weed. Its blue—sometimes pink or white—flowers, borne in little clusters upon stiff, straggling, almost leafless branches, are a familiar object along roadsides, fence rows, and even in fields in many parts of the country. But for its milky juice the perennial tap root might easily be mistaken for a parsnip, and the leaves resemble those of the dandelion, one of its near relatives.

FIG. 1.—Chicory plant (one-tenth natural size).

USES FOR CHICORY.

For ages chicory has held a place as a food for both man and beast. Some of its varieties were regarded as table delicacies by the Romans, others were employed for sheep grazing and cattle feeding. In Europe it is still one of the leading late salads, and its young leaves in early spring are as highly esteemed as spinach. The tender young roots, treated like carrots, are highly relished, especially in Belgium, and when full grown furnish, by special cultural processes, the celebrated *barbe de capucin* and *witloof* of Europe, two luxuries that America has unfortunately not yet learned to appreciate. The dried roots have been used by druggists as a substitute for the roots of dandelion and in the manufacture of taraxacum extract. After roasting, they

have been used to darken the color and to increase the bitter flavor of certain liquors, notably porter, and when pulverized as a substitute for and adulterant of snuff.

It is, however, as an adulterant of coffee that chicory is most widely known. For this purpose it was first used in Holland about one hundred and fifty years ago, but in America it was not employed until about forty years later. Its use was permanently established in Europe during the great Napoleonic blockade, when coffee, cocoa, and tea could with difficulty be procured. Under such conditions, adulteration was rife, the principal addition in the case of coffee being chicory, which was even entirely substituted. The people, having become accustomed to the use of chicory, either mixed with coffee or pure, during the blockade, demanded it upon the restoration of peace; and this forms a unique example of the creation of a taste by an adulteration which afterwards demanded a continuance of the adulteration, even to the point of complete substitution. Numerous substances, such as roasted cereals, peas, acorns, etc., have from time to time become commercially popular only to be abandoned, but chicory has held its own. So general has its use become that continental powers have enacted laws to prevent its adulteration, the penalties being as severe as for the sophistication of coffee, cocoa, or tea.

It is maintained by Europeans accustomed to its use that a mixture of two or three parts of good coffee with one of roasted ground chicory is superior to the coffee alone. From the standpoint of economy, also, the mixture is preferred, since it not only costs less but goes further. Americans, however, do not knowingly use it. Analyses of both the raw and the prepared product have so far failed to reveal the presence of any harmful substance, and neither the National nor the United States dispensatory condemns its use.

Until recently chicory growing in the United States has been of doubtful profitableness, the market being supplied very largely, if not wholly, by foreign fields. The principal difficulty in the way has been the prejudice of the chicory-consuming public, which is composed mainly of foreigners or their descendants, who have become accustomed to the European product and would not knowingly buy American-grown chicory because of its supposed inferiority. Impartial judges, however, declare domestic chicory to be at least equal in quality to the imported, though sometimes less attractive in appearance in its crude form. This is due to the use of a different style of cutting machine. During the past three years this opinion has been greatly strengthened by the establishment of chicory factories in America under the management of companies that had hitherto depended upon Europe for their supply of crude root. They found that American-grown chicory could be manufactured more profitably than could the imported root upon which they had to pay duty. As

a consequence, the imports of both crude and prepared chicory have fallen from $246,393 in the fiscal year 1897 to $13,414 in 1899.

It seems altogether probable that the chicory industry in America is upon its feet. If our laborers and artisans can not work for the low wages that the foreigners receive, this item of expense is more than offset by the improved machinery we use in both field and factory; so that, barring prejudice, there seems no reason why our fields should not supply at least American markets with this product.

CHICORY GROWING FOR THE ROOT.

WHERE IT IS GROWN.

Chicory is more particularly a cool climate crop, but is cultivated as a permanent agricultural crop in nearly every country of Europe. The Dutch, Germans, Scandinavians, and Northern French are the principal growers, consumers, and exporters. Great Britain produces little more than enough to supply home demands. In the United States, until recently, its cultivation was attempted in but a small way; but within the last three years it has been cultivated more largely with considerable success, and it seems probable that our own fields may in the near future supply our home demand. The range of its profitable culture will doubtless follow that of the sugar beet, the climatic and cultural conditions necessary to the development of the one being well suited to the other.

SOIL AND MOISTURE.

Except in the heaviest clay and the lightest sand, chicory will produce good crops in any soil, not too stony, which will yield profitable returns of beets, potatoes, or corn. Sandy soils are generally too dry; virgin soils are, as a rule, too rich in nitrogenous matter and produce an excessive growth of top and a small, woody root, worthless for manufacturing; clays are too hard to produce roots of first quality, and are likely to puddle, pack, and bake under the influence of heavy rains and hot suns; and stony soils are usually unworkable to the depth to which chicory fields must be plowed, particularly where the stones are large and deeply embedded.

For best results the chicory field should be a deep loam of moderate richness and medium texture, well drained and fairly level; the subsoil should be rather open, never dense nor hard, and should not contain tree roots or other obstructions, since they check the development of the long tap-roots and cause them to branch and subdivide into smaller roots. Roots of this character are very inferior in quality, in addition to being more difficult to dig and clean. In loamy soils, however, such difficulties do not occur, and, moreover, the plants may stand somewhat closer together than in heavier lands.

Provided the supply and distribution of water be normally equal, upland is as good as bottom land of similar texture; but no matter what its position, land too moist for cereals will be too wet for chicory. On the other hand, soil too dry for profitable grain production may still produce good chicory.

FERTILIZERS.

Stable manure is most frequently applied as a dressing for chicory, and for ordinary soils, properly managed, it gives fairly good results. But this manure is frequently too rich in nitrogen and too poor in potash and phosphoric acid, which are more necessary to the growth of this plant than is the former. For these reasons nonnitrogenous fertilizers should be applied at the rate of one and one-fourth to one and one-half times as much potash and two and one-half times as much phosphoric acid as have been removed by the preceding crop. Since these fertilizers do not induce redundant growth, excessive applications can do no harm. They are not lost like nitrogen in the drainage waters, but are more or less fixed and retained by the soil, and the grower should lose nothing, especially if he adopts some judicious rotation of crops. Potash and phosphoric acid should be used together, since they produce better results when used in conjunction than when applied separately.

It is considered best practice to apply stable manure in excess to the crop which precedes chicory. If this is not feasible, the stable manure may be applied in the autumn previous, and then only in a partially decomposed state. It may be spread either before or after plowing, the former preferred. Heavy applications in the autumn should be carefully avoided, since, if more nitrogen be applied than was removed by the preceding crop, there is danger of an excessive growth of top at the expense of root. In the use of potash and phosphoric acid, good practice sanctions their being applied in excess to the previous crop, choosing for such one that does not demand large quantities of these foods, so that much of them may remain in the soil for the chicory.

Should the growing of chicory upon heavy land, or upon soil that is somewhat sour, be necessary, an application of lime may be found useful in breaking up the soil and rendering it more porous; but since lime tends to form a hard-pan at the bottom of the furrow, great care must be taken to plow at varying depths in different years in order to break up and loosen this false subsoil. Lime also counteracts acidity in the soil, and may be used to hasten the decay of coarse litters when these are applied before being thoroughly broken up in the compost pile.

ROTATION.

Unless the land receives extra attention in the way of fertilizer and cultivation, rotation must sooner or later be practiced in the growing

of chicory as well as other farm crops. For a series of several consecutive years the crop may prove profitable, but the time will come when it will fail.

Since a scheme of rotation suited to the needs of every farmer or of every soil could not be named, it may be said that, in arranging the plan that suits him, the farmer should place chicory after some cereal crop (except corn), since the small grains are all harvested early enough to admit of fall preparation of the soil, a prerequisite in chicory culture. Two examples of suitable rotations may be given: (1) Clover, one crop cut for hay, the other plowed under; potatoes; cereal (wheat, barley, or oats); chicory. The potatoes may be left out if preferred. (2) Corn; some other cereal; chicory; clover. This scheme is worth adopting, since only two plowings are necessary, one for the corn, the other for the chicory. The wheat is sown among the corn stubble and the clover upon the harrowed ground in the spring after the chicory has been harvested. Where possible, the rotation should also include the feeding of stock, for which purpose a crop of oats and peas, or of barley and peas, to be used as green fodder, should take the place of the clover. In this way the soil may be doubly benefited, first by the leguminous crop and second by the manure from the stock fed.

PREPARATION OF SOIL

If a rotation scheme, such as has been recommended, be practiced, the land should be gang-plowed about six inches deep as soon as the cereal has been harvested. The surface should be kept loose and open by harrowing after each rain or once every two weeks until late fall, when it should be plowed not less than ten inches deep, the land being left loose and rough for the action of the frost during the winter. If the crop preceding chicory should be beets, potatoes, or mangels, the ground should be deeply plowed as just described as soon as the crop is off. In the spring the surface should be harrowed down and kept fine by the use of a weeder until seeding time arrives. Much time in after cultivation may be saved by planting the chicory immediately after the land is prepared for seeding, because of the better supply of moisture in freshly prepared ground.

PLANTING THE SEED.

When the ground has been brought into good tilth and the weather has become fairly settled, planting may be done.

The conditions favoring the germination of corn also favor that of chicory seed, although the latter may be planted at times that might be disastrous to maize. On no account should chicory be sown upon cold ground, because many seeds will decay, or be so injured that if they do manage to sprout they will produce weak plants. If planted

too early, a larger percentage of plants are likely to throw up seed stems and thus be worthless for manufacturing purposes. About the middle of May has been found satisfactory in Michigan and Nebraska.

A garden drill which will not clog and which will not crack the seed is usually the most satisfactory to use. It should drop the seed uniformly at the rate per foot of 20 to 30, which will be equivalent to 1 to 1½ pounds to the acre. The seed should be of the best quality; it should test at least 90 per cent purity, and should be grown specially for root production. Usually it is furnished by the factories, a practice that is satisfactory, since the quality is better than that of seed obtained in the open market.

The seed should be planted about one-third of an inch deep in favorable soil; less if the soil be moist, and more if dry. It should never be covered deeper than three-quarters of an inch, since most of the seedlings would be smothered before they could reach the surface. The rows should be 15 to 18 inches apart and should run north and south. An active man should be able to plant from 2 to 2½ acres a day.

In many American fields where the soil is fairly uniform in texture, free from stones, and reasonably level, wheel hoes and other hand cultivators are used, since they admit of the rows being only 12 inches apart and conduce to more uniform culture than where horse power is employed. Growers that have used both, declare in favor of hand hoes, because they obtain a heavier crop with them than with horse-power cultivators.

VARIETIES.

While there are many varieties of chicory used exclusively as vegetables and distinguished mainly by the form and color of their leaves, there are comparatively few well-established sorts used for roasting, and none so used exclusively, since the leaves of the roasting varieties, as well as those of the garden sorts, may be used for culinary purposes.

The varieties known as Brunswick and Magdeburg are of the same form (fig. 2*b*), the roots of the latter being somewhat longer, the leaves more erect and larger and with a less indented margin. The Magdeburg is also more productive, but harder to dig than the Brunswick. Schlesische (fig. 2*a*) has a short, blunt, thick root. Its form has much to commend it on account of easy digging; but, since it is not yet stable, and at present produces a considerable number of woody roots, it is being discarded for the two older varieties mentioned and for the Elite, a new variety resembling them in form.

In growing any of these varieties, however, the farmer must not conclude from the appearance of the tops that he has been swindled in his seed. The originators of the roasting varieties have paid most

attention to the root, the leaves being considered of very little importance. To find out whether he has been cheated, the grower must wait until the crop is dug.

CULTIVATION.

Two or three days after the seed has been sown the weeder should be run over the field, following the direction of the rows. This operation should be repeated at least once after the plants are up; twice would be better. When the plants are an inch or so tall they should be thinned to four inches apart. Two plants should not grow together, since the two roots will be smaller than one growing alone, while the labor of topping will be double. After the thinning, and when the plants have obtained a good foothold, the regular cultivation may commence. At first the ground should be scratched to the depth of only an inch or so, but later, as the plants grow and the season advances, this depth may be increased to two or even three inches. Chicory is impatient of deep cultivation, and never does so well as when shallow intertillage is practiced. Frequent shallow cultivation to keep the surface open is the rule. Some of the horse cultivators manage three and four rows at a time. They are very useful when the ground is free from obstructions.

FIG. 2.—Chicory roots and leaves; *a*, Schlesische variety, root with leaves; *b*, Brunswick and Madgeburg varieties, root. (Both one-sixth natural size.)

After the crop is laid by the only attention needed until harvest will be the removal of large weeds and of the chicory plants that send up flower stalks.

ENEMIES.

So far, no insect has given serious trouble to chicory growers that has not also been troublesome to the growers of other crops. Cut-

worms, wireworms, flea-beetles, and some other general feeding insects have proved destructive in various places. These may be combated in the same way as when they attack other crops. No diseases have as yet been observed or reported upon chicory, either cultivated or wild.

HARVESTING AND STORAGE.

Since chicory gains weight more rapidly during September than during any previous month, harvesting should not commence until after the first of October. Indeed, the later it can be done, without risk of injury by frost, the better. The roots are either harvested by throwing the earth away from one side of the row with a plow, after which they are pulled by hand, or they are slightly lifted by means of the chicory-root loosener (fig. 3), which is similar in prin-

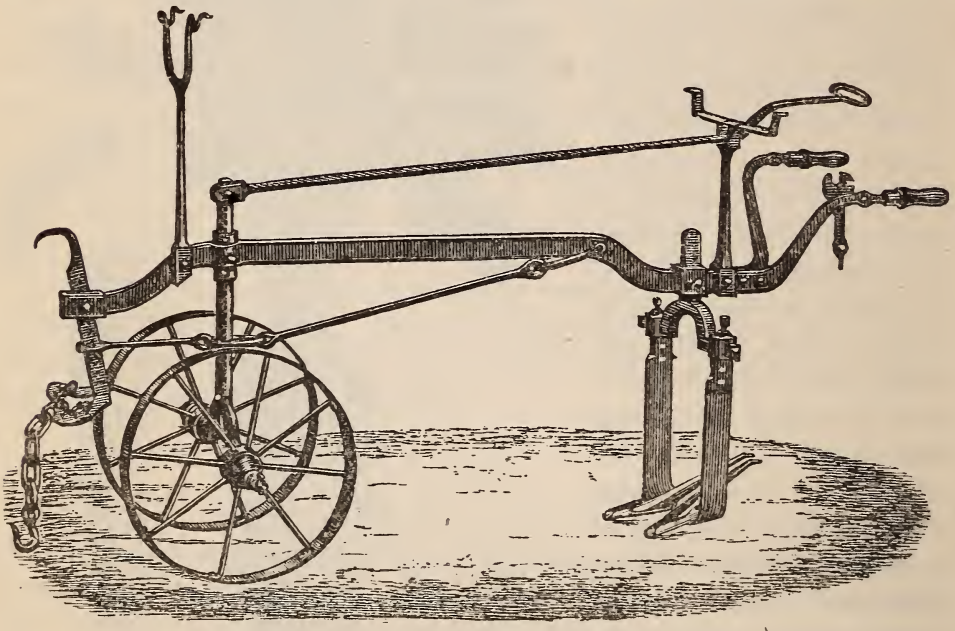

FIG. 3.—Chicory-root loosener for one row.

ciple to the implement used for harvesting beets. After being taken out of the ground they are topped and either sent to the factory at once, or placed in pits or root silos. The tops should be fed to stock, care being taken to feed but sparingly to dairy cattle, since a bitter flavor is imparted to the milk and butter when the tops are fed in large quantities. If it is necessary to leave the roots exposed after being topped, they should be covered to protect them from sun and wind. The tops make an excellent covering.

When it is necessary to place roots in storage, the position of the pit should be such as to prevent injury from water and frost. The bottom should be not more than 18 inches below the surface. The dimensions may be left to the individual. Four or 5 feet wide and 2 or 3 feet high above ground will generally be found most con-

venient. Upon the whole, however, it will be found best to ship to the factory as soon as dug, since the roots are then heavier and there is no risk of loss or injury.

YIELD AND PROFITS.

The following table, compiled from the reports of a number of growers in Michigan, Illinois, Wisconsin, and Nebraska, shows the highest and lowest averages in the various chicory fields, and also the final or general average for the whole country. It must be borne in mind, however, that the cost of raising depends largely upon the man and his methods. Upon these depend the yield and the consequent cash return. The table gives no figures relating to fertilizers, since this item of expense may be readily calculated by each grower for himself. By proper soil management and crop rotation, chicory should not demand very heavy applications of fertilizer, and should feed upon the stores of plant food left by the previous heavily manured crops of the rotation.

Average cost per acre of raising chicory.

Items.	Range of averages.	Final average.
Land rent, wear of tools, etc	$3.50 to $7.50	$5.42
Preparation of the land for planting	2.25 to 7.50	3.96
Cost of seed	.35 to .75	.64
Pulling up the "trumpeters"	.00 to .50	.20
Planting, thinning, and cultivating	12.00 to 20.00	15.15
Harvesting and delivering	7.35 to 18.00	11.76
Total cost	30.35 to 44.50	35.95
Average crop (tons)	6 to 10	8
Average price per ton	6.00 to 8.00	7.36
Receipts for the crop	45.00 to 68.40	59.29
Net profit	3.50 to 36.75	23.05

Though from 6 to 10 tons is the common range of production, as much as 15 tons may be raised with good culture. One grower has found that a yield of 5 tons will usually pay all the expenses enumerated above, any surplus above that being clear profit. Another, whose general crop averaged 8 tons and cost $20.50 delivered at the factory, found in the same year, by experiment upon 2 acres, that by the addition of only seven dollars' worth of labor his crop was a little over 11 tons to the acre. Since the price he received was $7.50 a ton, his investment of seven dollars' worth of muscle yielded a clearage of $15.50.

While it is occasionally safe to count, in ordinary, favorable seasons upon a net profit of from $20 to $25 an acre, it must not be forgotten that chicory is a special crop, and that it can not be raised with the certainty that there will be a demand for it such as there always is for wheat, cotton, potatoes, or other staple crops. Chicory has only a limited market which may be easily overstocked.

From the best information obtainable, it seems probable that the total consumption in this country, of both foreign and domestic chicory, could be supplied in reasonably favorable years by about 5,000 acres, if properly managed. It would, therefore, be unwise for the general farmer to plant except for home use, unless a guaranteed market at a stipulated price is assured by contract with one of the chicory manufacturing companies. Where such contracts can be made, if freight rates are not excessive, chicory may be found to pay well.

HOME MANUFACTURE.

When good chicory can not be obtained in the market, a supply may be obtained by home manufacture. The roots, carefully washed, should be cut into pieces not more than one-half inch in diameter and of irregular shape. In order to insure evenness in the roasting, the pieces should be of about the same size; slices should be avoided, since some are sure to be roasted too much and some too little. The pieces should be put in shallow biscuit or pie pans in the oven when there is a gentle, or at least not a very hot, fire. If larger quantities are to be prepared than can be conveniently accommodated in the kitchen, a coffee roaster, or perhaps a fruit evaporator, may be employed. The time necessary to dry the pieces will depend upon their size and the strength of the fiber. When thoroughly dry, the pieces should be brittle. While they are warm, however, they will be more or less soft and pliable.

Roasting may be done in an ordinary skillet or spider on top of the stove or in the oven. A small quantity of butter, lard, or oil should be melted in the pan, and the dried root should be stirred until the fat is all taken up. This agitation is necessary, since, if neglected, some pieces will be too greasy, the roasting will be very uneven, and the quality inferior. The pieces should acquire a deep-brown tint before being removed from the fire. If desired, the fat may be dispensed with, but the roasted roots will be then more prone to absorb moisture. When kept for any length of time, they will need to be thoroughly dried again if they are to be ground before using, because their absorption will make them more or less leathery and difficult to grind. It will probably be best on this account to roast only a small quantity at a time, since the dried root absorbs less water than the roasted.

It is not absolutely necessary to grind the pieces; they will yield almost as much of their strength to the water if whole as if ground. But when grinding is preferred, the coffee or spice mill will answer every requirement.

About one part chicory to four or five of good home-ground coffee is a fair proportion in which to mix the two, though some tastes may

prefer a different ratio. It is well to purchase only the best coffee in the form of beans, and to do the grinding at home. In this way freshly ground coffee, which is always to be preferred, may be had at any time to mix with home-grown chicory.

CHICORY GROWING FOR FODDER.

Chicory owes its value as a forage crop to its ability to produce well upon very poor, even almost barren, soils such as the extremely chalky soils of Texas. Its long taproots help to carry it through dry seasons in even the driest land.

In Continental Europe its cultivation has been practiced for centuries, though since the popularization of alfalfa it has declined in general favor. When used in the green state, either in the field or as a soiling crop, it is highly esteemed, since it may be cut at times when green food is usually somewhat scarce. Upon waste land it will frequently yield better than almost any other fodder crop, and yet it is grateful for generous treatment, being especially responsive in soils more or less rich in nitrogen, which substance tends to increase the growth of the tops. It may be sown either in drills or broadcast, about the first of May. In well-prepared ground, and if grown in drills, the plants should be thinned in much the same manner as when cultivated for the roots. For drilling, from 4 to 5 pounds of seed to the acre will be ample; for broadcasting, from 10 to 12 pounds will be required.

When chicory is used for feeding in the stall, at least one cutting may be made the first season, and sometimes even a second crop may be obtained late in the autumn, although when this is done it is generally at the expense of the vigor of the plants, and certainly precludes the possibility of obtaining a very early cutting in the spring of the following season, since the plants require more time to recuperate. In the second year three or four or even five cuttings can be made, and this may, under ordinarily favorable conditions, be continued for the four or five following seasons, particularly if the first cutting be made prior to the appearance of any flowers, say when the stalks are just commencing to branch and are still juicy and succulent. If left until later the stems become too tough and the vitality of the roots is likely to be impaired. As much as 20 tons of green food has been cut from an acre the second season and 38 tons the third and fourth years.

Since, when used as a fodder crop, chicory remains long upon the land, it can not enter into rotation systems except in the same way as do alfalfa and similar crops. But it so readily adapts itself to the poorer situations that it may be planted for forage upon the steep land and in out-of-the-way places, where it may be useful for grazing

and where most other forage crops are generally unsuccessful. When through age or other cause it becomes unprofitable, it may readily be eradicated by plowing and fallowing.

The only objection recorded against its use is that if fed in considerable quantities to milch cows it is liable to impart a bitter flavor to the milk. But turnips also unpleasantly affect the flavor of milk and butter when dairy cattle get all they desire, yet the turnip is not discarded. Where the dairy herd is fed in the stall, and where the food the cows get is under the control of the attendant, chicory may be added to their ration with advantage. Hogs are especially fond of the root and thrive upon it. Horses at first do not relish either the leaves or the roots, but having once acquired the taste they will eat them greedily. The plant seems to have an aperient, stomachic, and tonic effect upon the animal economy, and is also credited with preventing cutaneous disorders.

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